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LIFE AND WORK

OF

DARWIN.

BY

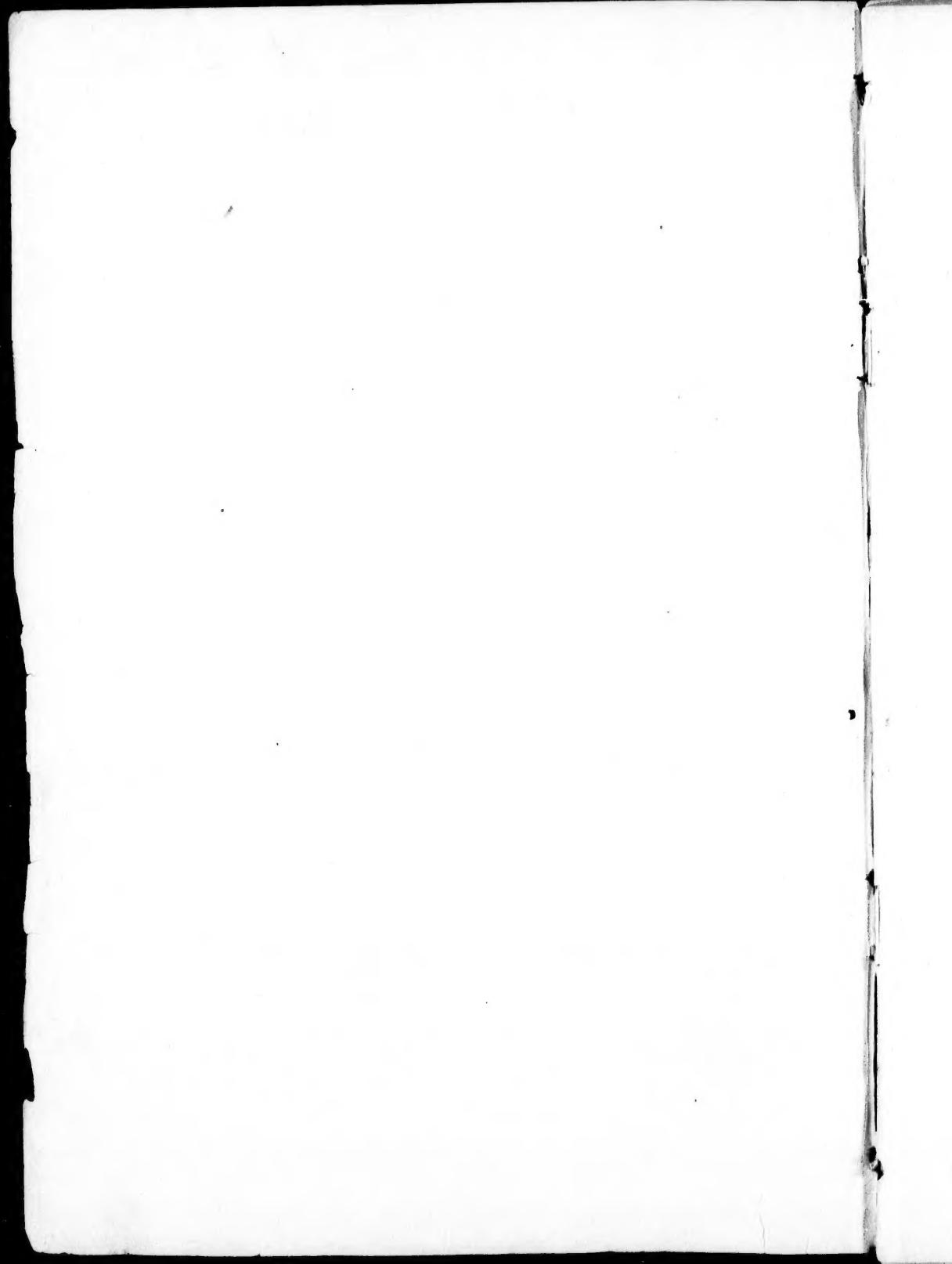
GEO. ACHESON, M.A., TORONTO.

Inaugural Address of President of University College Literary and Scientific Society—Session 1882-83, delivered in Convocation Hall, Nov. 10th, 1882.

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LIFE AND WORK OF DARWIN.

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WHEN this Society did me the honour of electing me to the presidential chair, it occurred to me that a suitable subject for my inaugural address would be one coming under the head of Science rather than Literature ; because, although the Society is called "Literary and Scientific," yet, of late years especially, its literary character has almost completely overshadowed its scientific aspect ; and I would like, in a small degree at least, to be instrumental in restoring to the latter part of this title some of the significance it was originally intended to possess. Accordingly I propose to direct your attention this evening to what appears to me to be one of the most important, as it is certainly one of the most interesting subjects connected with the history of modern scientific research : The Life and Work of Charles Darwin.

I know of no mind that has exercised such an influence on the current of scientific thought, or has been more effectual in making the nineteenth century illustrious, than that of the eminent naturalist, who, at his peaceful and happy English home at Down, in Kent, on the 20th of April, passed quietly away from the scene of his labours, having won for himself an imperishable reputation, not only as a patient, earnest, and successful observer of nature, but also as a most skilful reasoner, and the most important generalizer in the whole history of biological science. His claim to everlasting memory rests upon the fact that he established, or rendered sufficiently probable,

the immortal principle of Evolution, by suggesting as its reasonable cause the theory of Natural Selection.

The idea of evolution had occurred to other minds before Darwin's time, but it had never recommended itself to the judgment of science, because no adequate cause for any of the effects ascribed to it had been given, before he propounded his theory of natural selection. Whether this cause is the chief, or only a subordinate one, scientific men are by no means agreed; but once enunciated, it gave some probability to the theory of descent, and so wrought a complete revolution in almost every branch of science. Few men have been so wilfully, maliciously, and persistently misrepresented in all quarters, and especially by the pulpit and the press. Darwinism has been caricatured, burlesqued, and satirized by men of science, theologians, and humourists. Many of you doubtless can remember the antagonism and unreasonable opposition offered on all sides at the mention of his theories; but we have lived to see a great change. There is now scarcely a naturalist of any note, who does not accept the doctrine of descent in some form or other; sober-minded divines have ceased to regard his views as necessarily opposed to our conceptions of the omnipotence and glory of the Creator, or even to the generally received truths of revelation; and the speculations as to how apes lost their tails and turned into men no longer afford amusement to any but weak-minded enthusiasts and silly schoolboys. If not long ago, the notorious relationship with monkeys, was regarded as the sum and substance of the doctrine of descent, now we only hear such superficial condemnatory opinions from the most grossly ignorant. The old jest of inquiring why we do not see some ambitious gorilla, or high-toned chimpanzee, transforming himself into a man has now lost most of its force.

In contemplating Darwin's career it is difficult to say whether we should most admire his wonderful intellect or the beauty of his character. We can truly say of him, as he himself said of his friend and teacher, Prof. Henslow, of Cambridge, "Reflecting over his character with gratitude and reverence, his moral attributes rise, as they should do in the highest characters, in pre-eminence over his intellect." Only those who were intimate with him could understand

and appreciate the grand simplicity and sublime beauty of his character, and to others any language adequate to pourtray this must seem extravagant. The main features of his disposition seem to have been an all-absorbing love of truth, a total disregard of self, a keen interest in the pleasures of others, large benevolence, kindness, and generosity of heart, and permeating all a deep thoughtful wisdom, the whole forming a character eminently worthy of our love and reverence. All his thoughts and actions were characterized by intense honesty. No man more fully realized his own weakness; and therein lay his strength. He would accept suggestions and criticisms from anyone, even the most humble; and he spared neither time nor pains in collecting from every source all the possible information upon every subject which engaged his attention.

Charles Robert Darwin was born at Shrewsbury, England, on the 12th of February, 1809. His grandfather was the celebrated Dr. Erasmus Darwin, F.R.S., a physician of Lichfield, and author of several well-known scientific works. His father was Dr. Robert W. Darwin, F.R.S., also an eminent physician, remarkable for his quickness of perception and benevolent inclinations, qualities which were transmitted in greater degree to his son. His mother was a daughter of Josiah Wedgwood, a name well known in connection with the English pottery manufacture. Of his early boyhood very little is known. His education was begun at the Grammar School in Shrewsbury, under the direction of Dr. Butler, afterwards Bishop of Lichfield. In 1825, he was sent to Edinburgh, as it was his father's intention that he should study medicine. He remained there two years under the tuition of Prof. Jameson, but, as he did not profit much by his instructions, and was beginning to dislike the idea of a medical life, he was removed to Christ's College, Cambridge, with the view of his entering the Church. While here he came under the notice of the Rev. Prof. Henslow, who at this time occupied the chair of Botany. Between the two sprang up a life-long friendship and attachment, which was productive to both of much pleasure and benefit. To Prof. Henslow belongs the honour of first rousing in the mind of young Darwin an enthusiastic love for the study of natural science. It was in the field excursions of Henslow's class

that he first developed a taste for natural history, and before long he became a most zealous and successful collector, especially in entomology. His life at Cambridge, was a very happy one, much of his time being spent in the company of this amiable man, of whom he says, "I never once saw his temper even ruffled." He took the degree of B.A. in 1831, and that of M.A. in 1837, and his own University forty years afterwards, conferred on him the honorary degree of LL.D. The University of Leyden also gave him the honorary degree of M.D., in 1875. Besides these titles he possessed many others indicative of the honours conferred upon him from time to time by various British and foreign scientific societies.

During his last session at Cambridge, when the class was out on one of its usual excursions, Professor Henslow informed him that he had been asked to recommend to the Admiralty some young naturalist to accompany Captain Fitzroy, of H.M.S. *Beagle*, on a surveying expedition to the Southern Seas. This was the second scientific voyage of the *Beagle*, and Captain Fitzroy had expressed a wish to have a naturalist on board, and offered to give up part of his own accommodation if his request were acceded to. Accordingly application was made through Professor Peacock to Professor Henslow to recommend some one, and as Darwin thought this would give him the very best opportunity of studying the natural history of different countries, he decided to volunteer his services, which were accepted by the Lords of the Admiralty. A desire to travel had been awakened in him by reading Humboldt's "Personal Narrative," but his father was rather averse to the idea, as he was afraid it might alter his plans for entering the Church. However he was prevailed upon to give his assent, and, shortly after graduating, Darwin set sail with the expedition on the 27th of December, 1831. He served without salary, paying also part of his expenses, on consideration that all his collections should be at his own disposal. The object of the expedition was to complete the survey of Patagonia and Tierra del Fuego, to make a survey of Chili, Peru, and some of the islands in the Southern Pacific, and to carry a chain of chronometrical measurements round the world. It was this voyage which settled the whole course of his subsequent life. As his father feared, he never entered theology, but

devoted himself to the study and elucidation of natural phenomena with such a measure of success as rarely falls to the lot of any one man.

An account of his own labours in connection with this expedition was given by him shortly after his return to England in a work entitled a "Journal of Researches into the Natural History and Geology of the Countries visited during the voyage of H.M.S. *Beagle* round the World," or, as it is often called, a "Naturalist's Voyage round the World." This was originally published, along with a general account of the voyage by Captain Fitzroy, and afterwards separately. In this work appear the first glimmerings of his ideas on the doctrine of evolution of species. It would be useless to attempt to give in detail the numerous observations made during this voyage as they are contained in this book. I will just refer to a few of the most interesting.

In considering the fauna of North and South America in the Existing period, and comparing it with that of the period just preceding, he arrived at the conclusion that, within a comparatively late geological period, North and South America were much more closely related in the character of their land animals than they now are; and he accounts for this by supposing the great Mexican plateau to have been recently elevated, or more probably, the land in the West Indian Archipelago to have been recently submerged. At the present time, if America be divided by a line crossing the southern part of Mexico in latitude 20° , rather than through the isthmus of Panama, because at this point the great tableland forms an obstacle to the migration of species, we shall find that only a very few species have crossed the barrier, e.g., the opossum, puma, and peccari, and these have come from the south. We have North America characterized by many peculiar Rodents, and by the ox' sheep, goat, and antelope, genera belonging to the hollow-horned ruminants, a group of which South America does not possess a single species; while in South America we have numerous Rodents quite different from those of North America, a family of monkeys, several genera of Edentata (sloths, ect.), the lama, tapir, peccari, and opossums. Within a period however, when most of the existing shells were living, North America possessed the mastodon, elephant, horse,

and three large Edentates, viz., *Megatherium*, *Megalonyx*, and *Mylodon*, besides hollow-horned ruminants; and within the same period South America had a mastodon, horse, the same three Edentates (as well as others), a hollow-horned ruminant, and possibly an elephant. The conclusions from these facts I give in his own words: "When America, and especially North America, possessed its elephants, mastodons, horses, and hollow-horned ruminants, it was much more closely related in its zoological characters to the temperate parts of Europe and Asia than it now is. As the remains of these genera are found on both sides of Behring's Straits and on the plains of Siberia, we are led to look to the north-western side of North America as the former point of communication between the Old and so-called New World. And as so many species, both living and extinct, of these same genera inhabit and have inhabited the Old World, it seems most probable that the North American elephants, mastodons, horses, and hollow-horned ruminants migrated, on land since submerged near Behring's Straits, from Siberia into North America, and thence, on land since submerged, in the West Indies, into South America, where for a time they mingled with the forms characteristic of that southern continent, and have since become extinct."

While travelling along the Rio Parana he saw a very remarkable bird called the Scissor-beak (*Rhynchos nigra*). It is about the size of a teru, has short legs, web feet, and very long pointed wings; but the peculiarity about it is its beak. This is very much flattened laterally, and is quite elastic, and, unlike any other bird, the lower mandible is about an inch and a-half longer than the upper. They fly generally in small flocks rapidly backwards and forwards near the surface of the water, keeping their bills wide open, and ploughing the water with the lower mandible. In this way they plough up small fish and secure them between the blades of their scissor-like beaks. Occasionally they leave the surface of the water, and then their flight is wild and irregular, and they utter loud harsh cries. These curious birds are quite common along the course of the Parana, remaining there all the year round, and breeding in the marshes. Their fishing is done at night, and during the day they rest in flocks on the grassy plains at a little distance from the water.

A curious breed of cattle is described as occurring in the Province of Banda Oriental. The náta or niata cattle, he says, "appear externally to hold nearly the same relation to other cattle, which bull or pug dogs do to other dogs. Their forehead is very short and broad, with the nasal end turned up, and the upper lip much drawn back; their lower jaws project beyond the upper, and have a corresponding upward curve; hence their teeth are always exposed. Their nostrils are seated high up, and are very open; their eyes project outwards. When walking they carry their heads low, on a short neck, and their hinder legs are rather longer compared with the front legs than is usual. Their bare teeth, their short heads, and upturned nostrils give them the most ludicrous self-confident air of defiance imaginable." This breed is supposed to have originated less than 200 years ago among the Indians south of the Plata, and is a very true one, a niata bull and cow invariably producing niata calves. A cross with common cattle produces offspring having intermediate characters, but with the niata character strongly marked.

Among other curious and interesting observations, such as those relating to aéronaut spiders, causes of the extinction of organic beings, sense of sight and smell in condors, the remarkable lizard *Amblyrhynchus* found in the Galapagos Archipelago, etc., I will only notice his description of the Fuegians. After casting anchor in the Bay of Good Success, a party was sent to communicate with the natives, a number of whom had collected on the shore. He says, regarding this: "It was, without exception, the most curious and interesting spectacle I ever beheld. I could not have believed how wide was the difference between savage and civilized man. It is greater than between a wild and domesticated animal, inasmuch as in man there is a greater power of improvement. Their only garment consists of a mantle made of Guanaco skin, with the wool outside; this they wear just thrown over their shoulders, leaving their persons as often exposed as covered. Their skin is of a dirty coppery red colour. . . . The language of these people, according to our notions, scarcely deserves to be called articulate. Captain Cook has compared it to a man clearing his throat, but certainly no European ever cleared his throat with so many hoarse, guttural and clicking sounds." Again, speaking

of another tribe, he says : " These were the most abject and miserable creatures I anywhere beheld. On the east coast, the natives, as we have seen, have Guanaco cloaks, and on the west they possess seal-skins. Amongst these central tribes, the men generally have an otter-skin, or some small scrap about as large as a pocket-handkerchief, which is barely sufficient to cover their backs as low down as their loins. It is laced across the breast by strings, and according as the wind blows, it is shifted from side to side. . . . These poor wretches were stunted in their growth, their hideous faces bedaubed with white paint, their skins filthy and greasy, their hair entangled, their voices discordant, and their gestures violent. Viewing such men, one can hardly make oneself believe that they are fellow-creatures, and inhabitants of the same world.

At night five or six human beings, naked and scarcely protected from the wind and rain of this tempestuous climate, sleep on the wet ground, coiled up like animals. Whenever it is low water, winter or summer, night or day, they must rise to pick shell-fish from the rocks ; and the women either dive to collect sea-eggs, or sit patiently in their canoes, and with a baited hair-line without any hook, jerk out little fish. If a seal is killed, or the floating carcass of a putrid whale discovered, it is a feast, and such miserable food is assisted by a few tasteless berries and fungi." He also states that the different tribes when at war are cannibals, and also that when pressed by famine, as they often are, they kill and devour their old women before they kill their dogs, the reason given being, " Doggies catch otters, old women no." It was impossible to discover whether they had any idea of a future life or not. He had no reason to believe that they ever performed any sort of religious worship. Their nearest approach to a religious feeling seemed to be an idea of retributive punishment for wasting food, the elements themselves being the avenging agents. The different tribes have no government or chief, are hostile to one another, and speak different dialects. He concludes his description of these savages with the following remark :—" There is no reason to believe that the Fuegians decrease in number ; therefore we must suppose that they enjoy a sufficient share of happiness of whatever kind it may be, to render life worth having. Nature by making habit

omnipotent, and its effects hereditary, has fitted the Fuegian to the climate and the productions of his miserable country."

This voyage, however, was not all pleasure to Mr. Darwin. He mentions as the chief disadvantages several obvious losses, such as separation from the society of friends, one which he felt very keenly, though alleviated to some extent by a constant correspondence with his old master and dearest friend, Prof. Henslow, the want of room, seclusion, rest, and leisure, which "although at first not felt, tell heavily after a period." But worse than all, he suffered greatly from sea-sickness ; and this, together with the worry and fatigue incidental to his long land excursions, was the probable cause of the dyspepsia to which he was a victim ever after. I cannot here help referring to another life-long victim to dyspepsia, whose death but lately we were called to mourn. What a difference between the characters of Darwin and Carlyle—sunshine, gloom ! This physical affliction could not destroy the sweetness and amiability of the one, while the whole life of the other was so soured and warped by it, that as his mother expressed it, he was " gey ill to live wi." Indeed it is difficult to conceive of two characters so totally unlike ; and their modes of thought are as wide apart as the poles.

Three years after his return from this voyage Mr. Darwin married his cousin, Miss Emma Wedgewood, and in 1842 settled at Down, near Farnborough, in Kent. Here, up almost to the very day of his death, he continued to work at the problems which had been suggested to him while on board the *Beagle*, patiently accumulating and reflecting upon all sorts of facts which could possibly have any bearing upon that mystery of mysteries—the origin of species.

Taking his works in historical order, we have first a paper on the "Connection of Volcanic Phenomena," published in the transactions of the Geological Society in 1840. In the same publication, in 1842, there was another on the "Erratic Boulders of South America," and somewhat later, a paper on the "Geology of the Falkland Islands." His principle researches, however, in Geology were contained in a work called the "Geology of the Voyage of the *Beagle*," published in three parts under the auspices of the Lords of the Treasury. The first, on the "Structure and Distribution of Coral Reefs," appeared

in 1842, and must be regarded as one of the most original and interesting of the author's works. In this volume he gives his views on the formation of the three great classes of coral-reefs—Atolls, or Lagoon Islands, Barrier, and Fringing-Reefs. Important as these views are, I can only state here, that his theory is, that all the leading features in these structures can be simply explained by the upward growth of the corals during the sinking of the land. The formation appears first as a fringing-reef round an island or the shore of a continent. Now, if we imagine the island to sink and the coral to grow upward, we will get an encircling barrier reef; and if the same thing takes place with the continent, we will have a straight barrier. Let the encircling barrier reef and the island go on subsiding, and the corals growing vigorously upwards, and when the highest point of land has disappeared below the water, we have a perfect Atoll, or Lagoon Island. A conviction of the correctness of Darwin's theory has been impressed on the minds of many naturalists. Its simplicity recommends it.

The next part of this work was on the "Geology of the Volcanic Islands visited during the Voyage of the *Beagle*," published in 1844. The third part appeared in 1846, under the title of "Geological Observations on South America." These, together with a paper read in 1843, before the Geological Society on "Glacial Action in Wales," complete his direct contributions to Geology; but his researches in other fields have had a much wider influence on the progress of this science, especially his chapters in the "Origin of Species," on the "Imperfection of the Geological Record," and "Geographical Distribution." These have proved that geological history has followed a law of Evolution, not of Cataclysm or Uniformity..

Next in order of time comes his "Monograph of the Cirripedia," published by the Ray Society in two volumes, in 1851 and 1854. This exhaustive memoir shows the author's ability as a comparative anatomist, and his power to excel in the department of Morphology; but, as *Nature* says, "we have to thank his native sagacity that such was not his choice." Better things were in store for him. He was to influence the science of Zoology more by his generalizations

than by his particular researches, and the work which so completely revolutionized the scientific world was the "Origin of Species," first published in 1859.

The almost universally received idea concerning the origin of distinct animal and vegetable species, both fossil and existing, was that they were special, separate creations, variable within certain limits, but never passing into one another either suddenly or gradually. This doctrine had become so deeply rooted in the minds of both scientific men and theologians, that to express any doubt as to its validity or agreement with observed facts was regarded as rank heresy. In spite of this long-standing prejudice a suspicion entered the minds of a few, that this theory of special creation was inadequate to solve various problems in nature; that it was, indeed, quite at variance with some indisputable facts. Lamarck first formulated the doctrine of Descent in 1804 in his "Philosophie Zoologique." He held that species were not immutable, but that nature, starting with the formation of the simplest organic bodies, gradually evolved from these, in course of a long succession of ages, all organized beings, whether simple or complex.

In the "Origin of Species" Darwin upholds the theory of Descent, viz.: That all forms of life, both past and present, have been produced by a series of gradual changes in a few original forms in regular descent from parent to offspring; but in addition, he claims to have discovered the method in which this evolution of nature has taken place. Darwin's theory proper is not Evolution, as many suppose, but Evolution by means of Natural Selection. As one writer puts it, the idea of Evolution proved barren until it was fertilized by the idea of Natural Selection. How Darwin arrived at this idea he has told us in the introduction to the "Origin of Species," but more fully in a letter written to Haeckel, in which he says: "Having reflected much on the foregoing facts" (*i.e.*, facts in the distribution of the inhabitants of S. America, and in the geological relations of the present to the past inhabitants of that country), "it seemed to me probable that allied species were derived from a common ancestor. But during several years I could not conceive how each form could have been modified so as to become admirably adapted to its place

in nature. I began, therefore, to study domesticated animals and cultivated plants, and after a time perceived that man's power of selecting and breeding from certain individuals was the most powerful of all means in the production of new races. Having attended to the habits of animals and their relations to the surrounding conditions, I was able to realize the severe struggle for existence to which all organisms are subjected ; and my geological observations had allowed me to appreciate, to a certain extent, the duration of past geological periods. With my mind thus prepared I fortunately happened to read Malthus's "Essay on Population," and the idea of Natural Selection through the struggle for existence at once occurred to me. Of all the subordinate parts in my theory, the last which I understood was the cause of the tendency in the descendants from a common progenitor to diverge in character."

The general facts on which the theory of Natural Selection rests, viz. : the struggle for existence, variation, the survival of the fittest, and heredity were already known ; and it is somewhat strange that no attempt was made to correlate these, and find out the general principle underlying them, except by Mr. Darwin, and about the same time independently by Mr. Wallace.

In his introduction to this book Mr. Darwin says : " In considering the origin of species, it is quite conceivable that a naturalist, reflecting on the mutual affinities of organic beings, on their embryological relations, their geographical distribution, geological succession, and such other facts, might come to the conclusion that each species had not been independently created, but had descended, like varieties, from other species. Nevertheless, such a conclusion, even if well-founded, would be unsatisfactory until it could be shown how the innumerable species inhabiting this world have been modified, so as to acquire that perfection of structure and co-adaptation which most justly excites our admiration. . . . It is therefore of the highest importance to gain a clear insight into the means of modification and co-adaptation. At the commencement of my observations it seemed to me probable that a careful study of domesticated animals and cultivated plants would offer the best chance of making out this obscure problem."

Accordingly after due deliberation he took up the study of domestic pigeons, procuring every breed that could be obtained, reading all the literature he could find on the subject, and associating himself with several eminent pigeon fanciers. Great as are the differences between the breeds, it may be regarded as almost certain that they have all descended from the Rock pigeon (*Columba livia*). The various races such as the Pouter, Carrier, Fantail, Tumbler, Trumpeter, etc., differ from one another far more widely than do well-marked species of the same genus, or even family. And these modifications are produced by the will of man exercised in the process of selection. It might be as well to mention also here a phenomenon which Mr. Darwin has called "correlation of growth." This consists in the fact that while man may be intentionally modifying one part of the organism by selection, one or more other parts are unintentionally modified along with it, and become characteristic of the race.

Man's conscious power of modifying both the external and internal characteristics of domestic animals is too well known to require any lengthened description. This artificial selection operates by accumulating natural variations in certain directions. Man can never act by selection, except on variations first given him in some slight degree by Nature. Over all causes of change Mr. Darwin is convinced that the accumulative action of selection, whether exercised methodically and more quickly, or unconsciously and more slowly, but more efficiently, is by far the predominant power. The consideration of variation under domestication, and artificial selection introduces us to variation in a state of nature and natural selection. The fact of variation in domestic animals and cultivated plants is a self-evident one ; and the fact of variation in a state of nature, on a little consideration becomes equally so. Else what is the meaning of so many doubtful species, of monstrosities and sports? Amongst organic beings in a state of nature there is individual variability--no two beings are precisely alike. This fact, together with the high rate at which all organic beings tend to increase, necessitates a "struggle for existence." "Owing to this struggle for life, any variation, however slight, and from whatever cause proceeding, if it be in any degree profitable to

an individual of any species, in its infinitely complex relations to other organic being, and to external nature, will tend to the preservation of that individual and will generally be inherited by its offspring." This principle by which each slight variation, if useful, is preserved has been called "Natural Selection." The term "struggle for existence" must be understood in a wide and metaphorical sense, including the efforts a being has to put forth to accommodate itself to its environment, its dependence on other beings, the life of the individual, and its success in leaving offspring. More individuals are produced than can possibly survive; therefore, in every case there must be a struggle for life, one individual with another of the same species, or with individuals of a different species, or with surrounding physical conditions. In fact the life of every organism is a continual struggle with its environment. The relations existing between organic beings are often very complex. I will just give one instance noted by Mr. Darwin: "I have reason to believe that humble-bees are indispensable to the fertilization of the hearts-ease (*Viola tricolor*) for other bees do not visit this flower. From experiments which I have lately tried, I have found that the visits of bees are necessary for the fertilization of some kinds of clover; but humble bees alone visit the red clover (*Trifolium pratense*), as other bees cannot reach the nectar. Hence I have very little doubt, that if the whole genus of humble-bees became extinct or very rare in England, the hearts-ease and red clover would become very rare, or wholly disappear. The number of humble-bees in any district depends in a great degree on the number of field-mice, which destroy their combs and nests; and Mr. H. Newman, who has long attended to the habits of humble-bees, believes that more than two-thirds of them are thus destroyed all over England. Now the number of field-mice is largely dependent, as every one knows, on the number of cats; and Mr. Newman says: 'Near villages and small towns I have found the nests of humble-bees more numerous than elsewhere, which I attribute to the number of cats which destroy the mice.' Hence it is quite credible that the presence of a feline animal in large numbers in a district might determine, through the intervention first of mice and then of bees, the frequency of certain flowers in that district!"

Now in what way does this struggle for existence act in regard to variation? Just in this way. If any being vary, even slightly, in any way favorable to itself under the conditions in which it may be placed, this being will have a better chance of surviving in the struggle, and will thus be naturally selected. "It may be said that Natural Selection is daily and hourly scrutinizing, throughout the world, every variation, even the slightest; rejecting that which is bad, preserving and adding up that which is good; silently and insensibly working, whenever and wherever opportunity offers, at the improvement of each organic being in relation to its organic and inorganic conditions of life." From the strong principle of heredity any useful variation will have a tendency to be reproduced in the offspring, and so any selected variety will tend to propagate itself with its new characteristics intensified.

In addition to natural selection the general result of the struggle for existence, another important factor comes into play, where a desire for propagation is concerned, which Mr. Darwin calls "Sexual Selection." This depends upon a struggle between males for the possession of the females; and the result to the unsuccessful competitor is few or no offspring. It will not be necessary here to follow out the method in which this principle acts; it would seem, however, to be the cause of the modifications of the plumage in birds, and of the special means of defence of various male animals.

Natural Selection acts by the preservation and accumulation of infinitesimally small inherited modifications, each profitable to the preserved being. In this way varieties are produced, at first slightly, then strongly marked; and as the characters go on diverging the lesser difference between varieties becomes augmented into the greater difference between species.

Natural Selection also necessitates extinction. For, as we must suppose variations of all sorts to take place, some beneficial, others injurious, only the useful ones will be seized upon and preserved, while all the others will be ruthlessly destroyed as soon as they become injurious.

According to this theory the species now living are connected with older species by transitional forms or varieties, "species in

process of formation ;" these older species with others still more ancient, and so on ; so that an infinite number of forms must have existed. The so-called transitional forms known to us are few in comparison with this countless multitude. Many more doubtless will be brought to light as the science of Palaeontology grows older, but the geographical record is necessarily very imperfect, and the transitional forms must, from the very nature of Natural Selection, be of short duration. Therefore we must not be at all surprised if in many cases we do not see the connecting links between species. As Mr. Darwin says, "our ignorance of the laws of variation is profound. Not in one case out of a hundred can we pretend to assign any reason why this or that part differs more or less from the same part in the parents. But whenever we have the means of instituting a comparison, the same laws appear to have acted in producing the lesser differences between varieties of the same species, and the greater differences between species of the same genus." He enumerates, however, some of the probable causes for this deviation in structure. It can easily be proved that the reproductive system is greatly influenced by changes in the conditions of life ; and he believes that the varying or plastic condition of the offspring is to be attributed to the functional disturbance of this system in the parents. The direct effect of external conditions such as climate, food, etc., he thinks is very slight. Habit, use, and disuse seem to be more potent. Correlation of growth has great influence ; multiple parts are very variable, because not having been closely specialized to any particular function, their modifications have not been closely checked by Natural Selection. Probably from the same reason, organic beings low in the scale are more variable than those higher up. Specific characters are more variable than generic characters. Secondary sexual characters are also highly variable, and parts developed in an unusual manner. Species descended from a common parent, and exposed to similar influences, will naturally tend to present analogous variations, and may occasionally revert to some of the characters of that parent.

The theory of evolution explains the nature of the affinities of all organic beings. All animals and plants, both existing and extinct,

are related to each other in group subordinate to group, so that it is possible to arrange them all in varieties, species, genera, families, orders and classes, more or less closely connected with one another. They cannot be ranked in single file, it is true, but the subordinate groups seem to be clustered round points, and these round other points, and so on.

There are a great many other things in connection with this theory which I should like to have noticed, did time permit, such as the difficulties surrounding it, though, it would seem, not fatal to it, the evolution of instinct, the facts of sterility and hybridism, the application of the theory to man, and its relations to Christianity. On this last head, I will just say, that in my opinion the doctrine of Descent and the facts in connection therewith harmonize completely with the teachings of faith, and the belief in a personal, omniscient God, acting through these natural laws instituted by His will and sustained by His providence. As far as the application of the theory to man goes, I believe that his physical organization has been evolved by the ordinary operation of natural laws, which are but expressions of the Creator's will; while his soul, or higher nature, an entirely different existence from his body, was created, not through the operation of secondary pre-existing means, but by the direct action of the Almighty. And this view Scripture plainly seems to set forth, when it says: "God made man from the dust of the earth (*i.e.* his body) and breathed into his nostrils the breath of life" (*i.e.* his soul). To those who ignorantly ask for the missing links between monkeys and man, I have to say, that Darwin never told us that man was descended from any of the apes, but only that man and the anthropomorphous apes are descended from a common extinct progenitor, along diverging lines; and that it is the height of absurdity to suppose that an evolutionist ought to be able to show how a gorilla transformed himself into a man, any more than he ought to be able to prove to the satisfaction of the most incredulous, that by stripping the hair of a squirrel's tail he could change it into a rat!

Whether we accept Darwin's theory of Natural Selection or not does not alter the fact of Evolution, for it is quite possible for the theory of Natural Selection to be entirely false, and the doctrine of

Descent still true. Mr. Darwin's greatest achievement perhaps in this work is, that he has finally established the fact of Evolution. That he has finally shown that Natural Selection is the cause of Evolution, I am not prepared to say. The law which impels the variation of species in known directions may be Natural Selection, or it may be an inherent principle of development working according to natural laws yet unknown, or perhaps both of these combined ; but I believe all organic forms have been evolved by ordinary natural laws expressive of the Divine will, and acting "in obedience to a creative fiat originally imposed on the primeval Cosmos, 'in the beginning,' by its Creator, its Upholder, and its Lord."

In the closing words of the "Origin of Species," "There is a grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one ; and that whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved."

I have dwelt at such length on the "Origin of Species" that I have very little space left for glancing at Mr. Darwin's subsequent works. Some of them I can only just name. In 1862 appeared a work on the "Fertilization of Orchids." In 1867 he published a volume on the "Variation of Animals and Plants under Domestication," he intended as the first of a series of memoirs on the great subject of which the "Origin of Species" was only an abstract. He promised in a second to deal with the "Variation of Organisms in a State of Nature," and in a third to "try the principle of Natural Selection by seeing how far it will give a fair explanation of the several classes of facts alluded to."

In 1871 was published his work on the "Descent of Man, and Selection in Relation to Sex," where he traces man back to a "hairy quadruped furnished with a tail and pointed ears, probably arboreal in his habits, and an inhabitant of the old world." Of this book the author himself says : "I am aware that the conclusions arrived at in this work will be denounced by some as highly irreligious ; but he who thus denounces them is bound to show why it is more irreligious to explain the origin of man as a distinct species by descent from some

lower form through the laws of variation and natural selection, than to explain the birth of the individual through the laws of ordinary reproduction. The birth, both of the species and of the individual, are equally parts of that grand sequence of events, which our minds refuse to accept as the result of blind chance. The understanding revolts at such a conclusion, whether or not we are able to believe that every slight variation of structure, the union of each pair in marriage, the dissemination of each seed, and such other events have all been specially ordained for some special purpose." As I have said before, we must remember that Darwin does not trace man's descent from any existing ape, but holds that both have descended from a common ancestor now extinct, the modern ape having retained more of the characteristics of the parent form than man. He shows that the original tail and pointed ears exist in man in an aborted or rudimentary state, and are much more prominent in the embryo than in the adult. To the action of sexual selection he attributes both the want of hair, and its peculiarities of growth and varieties of texture and colour. Although he is quite conscious of the difficulties surrounding the question, he holds that both man's superior mental qualities and his superior moral qualities can be traced to evolution acting through natural and sexual selection, just as in the case of domesticated animals, where we know that mental qualities are variable, and the variations are inherited. Upon this point of course many will disagree with him, even those who are quite willing to accept the doctrine of evolution in regard to *material* forms. Although Darwin's investigations led him to believe in the unity of the human race, yet he did not regard mankind as the descendants of a single pair, but held rather, that a whole tribe of ancient quadrupeds gradually acquired human characteristics. Of the anatomical resemblances between man and the existing apes a great deal has been written; and here I will only say what every comparative anatomist knows, that the structural differences between the lower and higher apes are far greater than between the latter and man. This subject of the Descent of Man is probably the most interesting part of the theory of evolution, to a popular audience; but I must hurry on, having made this brief allusion to it.

Mr. Darwin's more recent volumes are on the "Expression of Emotions in Man and Animals," published in 1872; "Insectivorous Plants," in 1875; "Cross and Self-fertilization in the Vegetable Kingdom," in 1876; "Different Forms of Flowers in Plants of the Same Species," in 1877; "Movements of Plants," in 1880; and his last work, in 1882, on the "Formation of Vegetable Mould, through the Action of Worms, with Observations on their Habits."

The main object of all these works has been to supply the data upon which he founded the great conclusions of the "Origin of Species," and they all combine to illustrate the incessant and infinite interaction of the various parts of nature upon each other, and the way in which the most noticeable results have been produced by causes seemingly unimportant, but all powerful in their gradual accumulation.

Before closing I must say just a word on his latest work. It is curious to note that one of his first published papers was upon the very same subject. In 1837 he read a paper before the Geological Society of London on the "Formation of Mould," which, as in the present work, he attributes mainly to the agency of earthworms. This fact is an admirable instance of the continuity of Mr. Darwin's thought and writings. Each work is the result of years of patient labour, and it is this which gives such value and weight to his writings. For more than forty years he was engaged in investigations on the subject of the formation of mould, and in working out the idea that earthworms are among the most powerful forces of nature, and that they play a very important part in the physical changes of the earth's surface. His first paper was ridiculed by several distinguished French naturalists, but he has now proved conclusively "that all the vegetable mould over the whole country has passed many times through the intestinal canals of worms." In this book he first gives an account of the habits of these lowly animals. They require a certain amount of moisture for their existence. They crawl about chiefly at night. They can neither hear nor see, though they are not altogether insensible to light; but they possess the sense of taste and smell to a certain extent, and their sense of touch is strongly developed. Their food consists of leaves and any diges-

tible matter contained in earth, of which they swallow an extraordinary quantity. They have a certain amount of reason as well as instinct, as evidenced by the way in which they draw leaves into their burrows. These leaves they use not only as food, but for the purpose of plugging up the mouths of their burrows; and they almost always draw them in by their narrow ends. These burrows are made partly by pushing the earth aside, but principally by swallowing it, extracting the digestible matter, and then ejecting it from the intestinal canal in the form of so-called "castings;" and it is in this way that they act in modifying the surface of the earth. Mr. Darwin, with the help of his sons, made a series of experiments to determine whether or not these creatures were capable of performing the immense amount of work he was inclined to attribute to them; and he found by weighing the castings thrown up within a certain time in a measured space, and making the necessary calculations, that "in many parts of England a weight of more than ten tons of dry earth annually passes through the bodies of worms, and is brought to the surface on each acre of land; so that the whole superficial bed of vegetable mould passes through their bodies in the course of every few years." And he calculates that in Great Britain alone no less than 320,000,000 tons of earth is annually brought up to the surface of the ground by worms. We see, then, what an important part they must play in the burial of various objects, such as stones, buildings, monuments, etc., and especially what great assistance they must give to other geological agents in the denudation of land. They also perform a very useful work in preparing the ground for cultivation and rendering it fertile.* Mr. Darwin concludes the book with the following striking passage: "When we behold a wide, turf-covered expanse, we should remember that its smoothness, on which so much of its beauty depends, is mainly due to all the inequalities having been slowly levelled by worms. It is a marvellous reflection that the whole of the superficial mould over any such expanse has passed, and will again pass, every few years through the bodies of worms. The plough is one of the most ancient and most valuable of man's inventions; but long before he existed the land was in fact regularly ploughed, and still continues to be thus ploughed by earthworms.

It may be doubted whether there are many other animals which have played so important a part in the history of the world as these lowly organized creatures. Some other animals, however, still more lowly organized—namely corals, have constructed innumerable reefs and islands in the great oceans ; but these are almost confined to the tropical zones." So ends this author's last work ; and it is no unworthy culmination of the labours of a most remarkable scientific career.

In this sketch I have made numerous quotations from his writings, because I believe that the best conceptions of his views can be gained by allowing him to speak for himself.

Mr. Darwin leaves behind him five sons and two daughters. Two of his sons have already distinguished themselves in the field of science, one of them—Mr. Francis Darwin—lately elected F.R.S., having been for some years his father's secretary and faithful and able assistant.

Ever since his return home from the voyage in the *Beagle* he suffered from frequent attacks of nausea, from which he could gain no permanent relief ; and it was an attack of this kind, continued for some days, that eventually was the cause of his death. The somewhat sudden announcement of this startled and shocked the world, and called forth such a manifestation of love and reverence as has seldom been bestowed upon its greatest heroes. By the unanimous wish of the nation his remains were laid to rest in an honoured grave in Britain's great mausoleum by the side of her noblest sons, the whole world his mourner. With more truth, however, can it be said of him than perhaps of any other man, that he "being dead yet speaketh."